Quantitative evaluation of regional precipitation forecasts using multi-dimensional remote sensing observations (QUEST)

Project proposal related to: area A (physical processes)
area B (improved field observations)
area C (data assimilation, validation)
area E (preparation of field experiment)

Partnership

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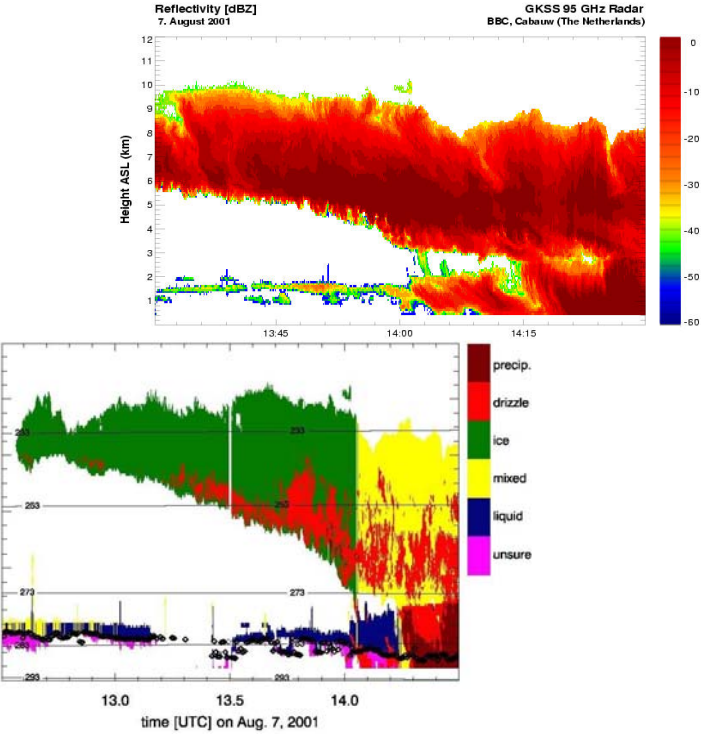
Objective

Improve **quantitative precipitation forecasting** by evaluating the representation of moist processes determining the amount of precipitation at the ground



multi-dimensional remote sensing data are best suited to observe the spatial-temporal distribution of **water in all its phases**.

establish a framework for a physically based quantitative evaluation and improvement of weather forecasts employing as extensively as possible **existing and upcoming remote sensing** data.

Specific Objectives

- Establish a data base of quality controlled ground-based and satellite remote sensing observations and corresponding Lokal-Modell simulations

  start directly from the beginning of SPP

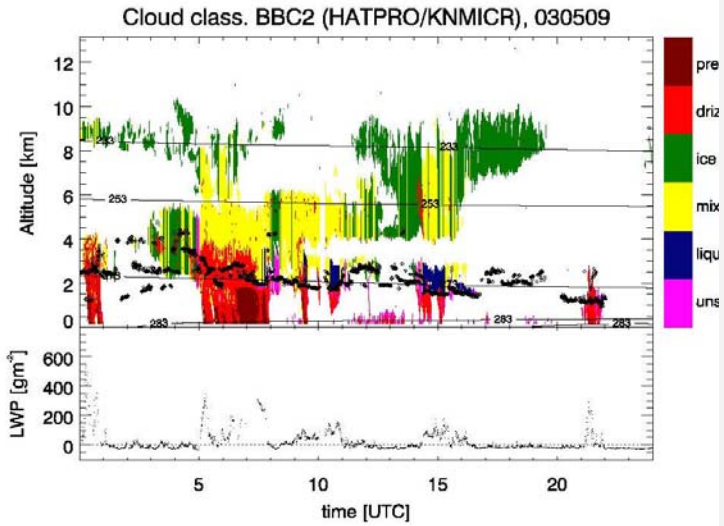
- Develop a set of forward modelling tools to simulate as completely and as accurately as possible the multi-dimensional observations from model output

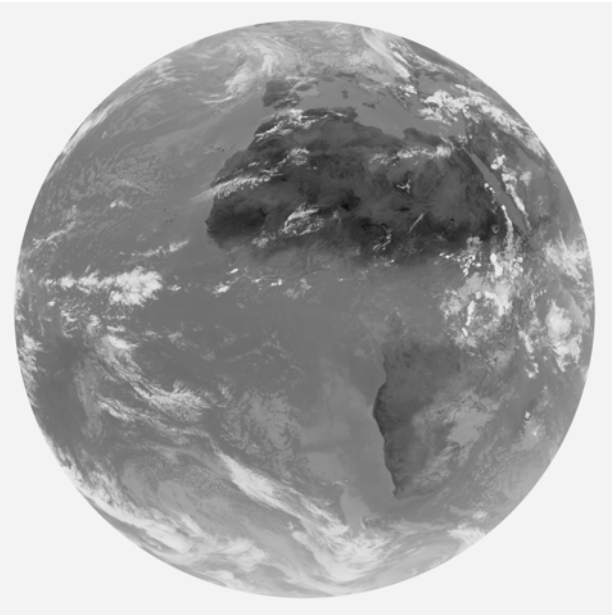
- Use data from field experiments to investigate the process chain from water vapour to precipitation at the ground

- Perform a long-term evaluation of Lokal-Modell forecasts using the **observation-to-model** and **model-to-observation** approaches

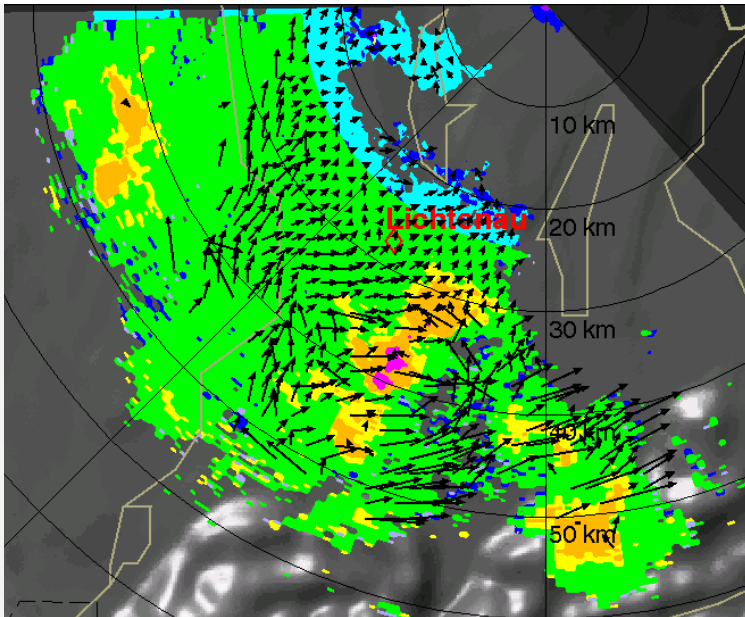
Existing data sets

- **Vertical distribution** of LWC, IWC, humidity, temperature,.. at Cabauw/Lindenberg (CLIWA-NET data set)
- **Horizontal distribution** of water vapor, cloud properties from satellite (MODIS, MSG, MERIS, AMSU, AMSR)
- **3-dimensional** distribution of *polarimetric* radar parameters from POLDIRAD (+3D wind) and X-Band radar Bonn





snow graupel hail



Workplan

Exploitation of data

- Improve LM **radar simulation** model (RSM) to calculate synthetic polarimetric radar products (**ZDR, LDR, rho$_{HV}$(0), KDP**)
- Create **microwave/IR simulator** for LM to calculate synthetic ground-based and satellite (**AMSR**, AMSU, EGPM, sub-mm) measurements

Evaluation in terms of observables

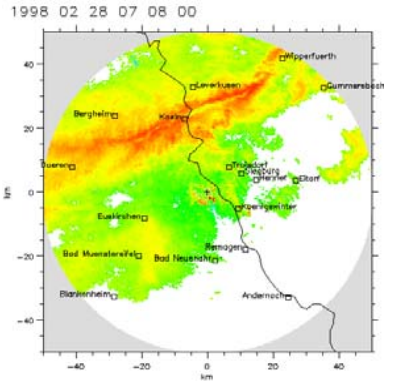
- Application of synergetic algorithms to ground-based and satellite data
  - water vapour **(MERIS, MODIS, SEVIRI)**
  - liquid and ice water properties (")
  - precipitation (rain, snow, light rain, drizzle)

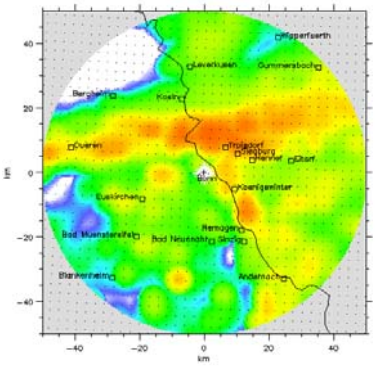
Evaluation in terms of model variables

Evaluation Approach

Observations

- multi-frequency radiances
- polarimetric radar quantities





Retrieval

- water vapour
- cloud properties
- precipitation

Forward Operator

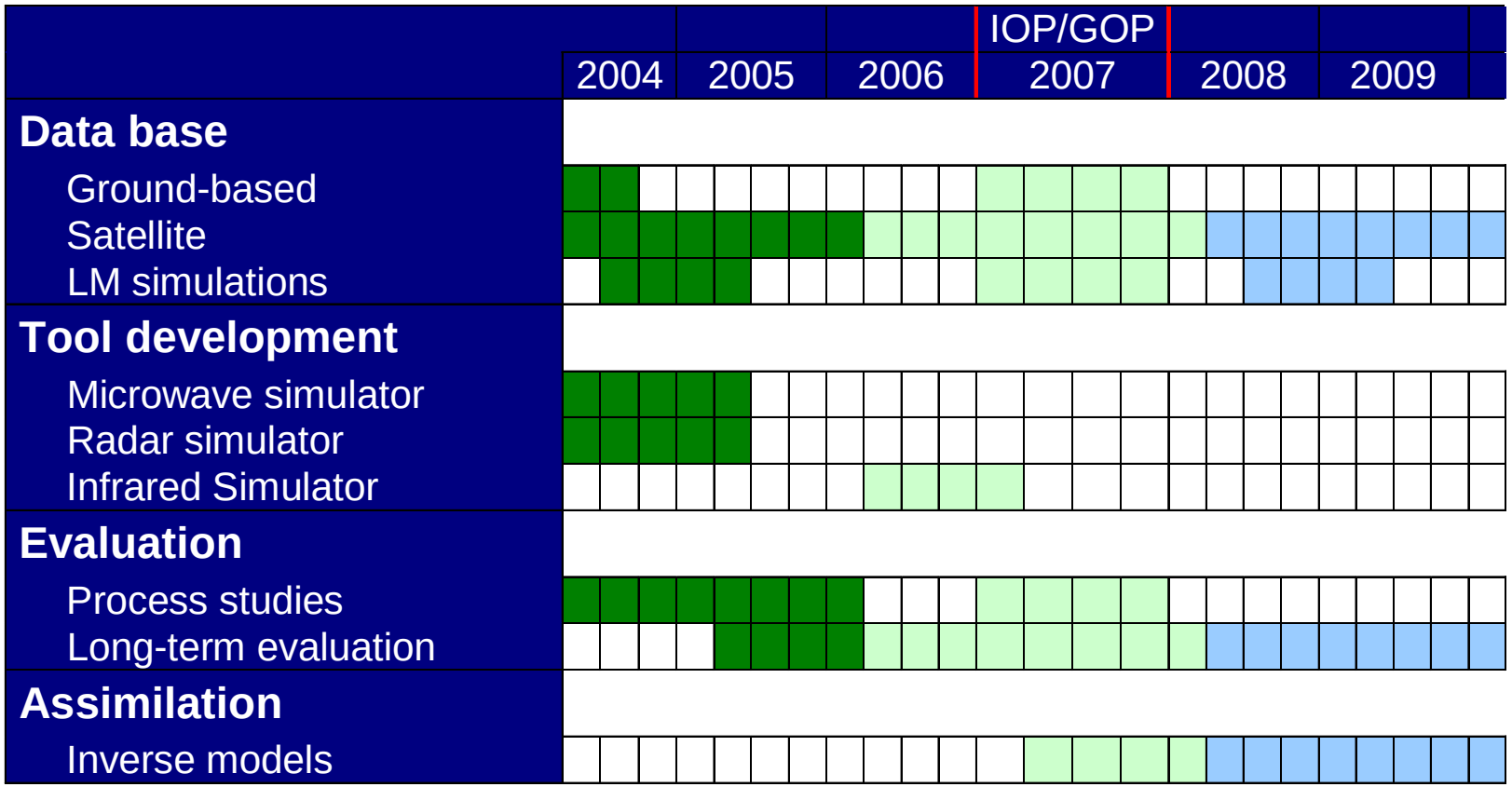
Radar and satellite simulator

- scattering data base
- interface to LM microphysics
- surface emissivity
- viewing geometry

Weather Forecasts

three-dimensional description of
the forecasted atmospheric state

Time Table


IOP/GOP
2004
2005
2006
2007
2008
2009
Data base
Ground-based
Satellite
LM simulations
Tool development
Microwave simulator
Radar simulator
Infrared Simulator
Evaluation
Process studies
Long-term evaluation
Assimilation
Inverse models

Deliverables

- data base accessable for all SPP partner
  complementary remote sensing observations
  with matched Lokal-Modell diagnostics
- forward models
  - polarimetric radar parameters
  - microwave brightness temperatures over land/ocean
- identify systematic model shortcomings and make
  recommendations for model physics
- evaluation environment for Lokal-Modell and
  preparation for future variational assimilation

Optional Extensions

- community satellite simulator tool (CSST) for LM
- Integration of cloud parameterization package

Requested Funding

- 1 Post-doc (Munich),
- 3 PhD students (DLR, FUB, Bonn)
- 4 Student workers
- consumables and travel

References

Albert, P., Bennartz, R., Fischer, J. (2001): Remote sensing of atmospheric water vapor from backscattered sunlight in cloudy atmospheres, *Journal of Atmospheric and Oceanic Technoly*, **18**, 865-874.

Bauer, P., D. Burose und J. Schulz, 2002: Rain detection over land surfaces using passive microwave satellite data. *Meteorologische Zeitschrift*, 11, 37-48.

Crewell, S, M. Drusch, E. Van Meijgaard and A. Van Lammeren, 2002: Cloud Observations and Modelling within the European BALTEX Cloud Liquid Water Network, *Boreal Environment Research,* 7, 235-245.

Haase, G. and S. Crewell, 2000: Simulation of radar reflectivities using a mesoscale weather forecast model. Water. Res. Res., 36, 2221-2230

Löhnert, U., S. Crewell, A. Macke and C. Simmer, 2001: Profiling cloud liquid water by combining active and passive microwave measurements with cloud model statistics, J. Atmos. Oceanic Technol.Vol 18 (8) 1354-1366

Schulz, J. und P. Bauer, 2002: An improved estimation technique for rainfall over land surfaces using active and passive microwave satellite data. *Recent advances in quantitative remote sensing*. Ed. Jose A. Sobrino, University of Valencia, ISBN 84-370-5515-6, 751-760.